
SOME NEGLECTED ASPECTS OF PLANT MICROFOSSIL RESEARCH

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The increased utilization of plant microfossils, especially by industry, has served to emphasize problems which have existed for many years. One of these is the difficult problem of classification and the urgent need of giving it serious attention. There is also an increasing disregard for the botanical affinities of microfossils. This is somewhat disturbing since we are dealing with the field of biology and with entities possessing botanical significance. There are numerous reasons for the existing ambiguity in plant microfossil classification, and continuance of many present practices may well result in a taxonomic maze that will serve to impede progress in pollen and spore research. A general tendency to ignore natural affinities of dispersed spores is evident with even a brief perusal of current literature, and the presence of a few arbitrary features common between entities is being increasingly used as a classification tool. Part of the cause is readily apparent since plant microfossils have proven to be useful operational tools with industrial applications, and there is a natural desire to put the entities to practical usage as quickly as feasible. Very often it is possible to make stratigraphic correlations with plant spores or pollen without regard to their natural affinities.

There are numerous classification systems, all probably useful to some degree, none completely satisfactory, and all contributing further to the entangled nomenclature of plant reproductive disseminules. Most of these studiously avoid any systematic treatment using demonstrated connections between fructifications and their spores. Several workers have given attention to the nomenclatural problems, and as Sen (1958) has noted, one solution is to study spores from identified fructifications and thus determine the limits of a spore species. This may appear to be an appallingly slow method, but it is one which can provide concrete corrobora-

tive evidence of the relationship of spore forms and determine whether similarities possess phyletic implications. Too frequently, paleobotanical investigators persist in ignoring phyletic evidences even when demonstrated links between spores and fructifications illustrate the conspecific nature of isolated specimens. Some of the Paleozoic small spores stand out as glaring examples of the failure by investigators to heed botanical relationships.

The spore genus *Planisporites* is an example, for in it are forms which have no suggestion of a natural genus, while there are also included in it by some authors spores attributal to a parent fructification. In *Planisporites* we have a genus that, as defined by Knox (1950), included circular and triangular spores without ornamentation or with walls granular to punctate. Potonié and Kremp (1954) in emending Knox's genus made note of her broad definition and the inclusion of species which appeared referable to other established genera. They designated *Planisporites granifer* (Ibrahim) Knox as the genotype and restricted the genus only to species possessing very small, closely spaced coni as ornamentation. In their emendation, however, they also included circular and triangular spores in the genus, and indeed their emended description appears superficial. It seems only to serve as an additional dumping ground for several entities once assignable to *Punctatisporites*. Admittedly *Punctatisporites* has long needed redefinition as there is no semblance of a natural genus in its present state. However, *Planisporites* as emended by Potonié and Kremp does not indicate a natural division in the light of our paleobotanical studies, for there are several examples of spores attributal to parent cones and assignable to *Planisporites* (sensu Knox). Chaloner (1953c), in a treatment of *Sigillaria* fructifications, isolated and described from *Sigillariostrobus rhombibracteatus* microspores assignable to *Planisporites* (sensu Knox). He also noted that the microspores of *Mazocarpon oedipternum*, a Sigillarian cone, were similar to the spores of *S. rhombibracteatus*. Felix (1954), in a study of *Lepidostrobus Gallowayi*, found the microspores most nearly assignable to *Planisporites*. The fact that this cone does possess Sigillarian characteristics further suggests *Planisporites* to be Sigillarian.

This is not to suggest that spores of the fructifications noted above afford conclusive evidence of Sigillarian affinity, but here are examples which may be included in *Planisporites* as defined by Knox (1950) but must be excluded by the emendation of Potonié and Kremp (1954). Thus we have spores definitely assignable to the arborescent lycopods but without a generic designation as *Planisporites* is presently emended. Nameless or named, such spores offer a step from the taxonomic morass of the form genus *Planisporites*, but as used by recent workers such as Potonié and Kremp (1955) and Bhardwaj (1957) we still have a genus whose organic connection with a parent plant is unknown. If *Planisporites* were to be retained, it would have seemed more logical for the emendation to have applied it to spores with established affinities rather than to ignore those spores from described fructifications.

The small spore *Lycospora* is one of the most characteristic of the Paleozoic coals, and in all probability more is known about it than any other spore. Its natural relationship is well established with the arborescent lycopods of the coal forests. Present from the upper Mississippian, it is abundant in most Pennsylvanian deposits to the middle Missourian, where it abruptly disappears. The genus as defined by Schopf, Wilson and Bentall (1944) included small spores 18 to 45 microns, possessing an equatorial ridge without a distinct flange; it was assignable to the cone genus *Lepidostrobus*, the fructification in turn being borne on *Lepidodendron*. Subsequent workers, particularly Kosanke (1950) and Potonié and Kremp (1955), have noted a membranous, continuous flange in species assignable to *Lycospora*. However, Hoffmeister, Staplin and Malloy (1955) have transferred *Lycospora minutus*, *L. pseudoannulata*, and *L. punctata* to the genus *Cirratriradites*. They have distinguished between the genera in that *Cirratriradites*

has the sutures extending to the edge of the spore body and usually continued as thickenings to the edge of the equatorial flange; in *Lycospora* thickened extensions of trilete rays are not developed on the narrow equatorial girdle. This deduction is based on the absence of extensions of the suture onto the girdle of the genotype, *L. micropapillatus*.

The importance given the length of the suture's extension by Hoffmeister, Staplin and Malloy hardly seems warranted in light of other worker's results. Kosanke (1950) noted the rays generally extending nearly to, or to the margin of the spore coat. This writer has noted in coals, especially where *Lycospora* comprises a high numerical percentage, that there is often no established pattern of ray extensions. Particularly in the Index Hill coal of Morgan County, Kentucky (unpublished study), a flanged *Lycospora* was observed in which the rays sometimes continued to the edge of the flange, other specimens did not have the ray extensions, and occasionally specimens were viewed in which both types of rays were present on the same spore.

The presence of the small equatorial flange is a systematic difficulty since early known species of *Lycospora* were not described as having a distinct flange development. The distinct, membranous flange of the rather large *Cirratriradites* was therefore sufficient to set the genera apart. However, conclusive evidence that the systematic position of flanged, small spores should also be with *Lycospora* has been shown by studies of Chaloner (1953b) and Felix (1954), where the specimens were demonstrated to be microspores of *Lepidostrobus*. The larger *Cirratriradites*, including the genotype, agrees with *C. annulatus* Kosanke and Brokaw in most respects. The studies of Chaloner (1954) and Hoskins and Abbott (1956) have conclusively shown it to be a microspore of *Selaginellites*.

However, despite good morphological evidence that these two spore genera are assignable to two distinct cone genera, can the student of paleobotany assume that the establishing of natural affinities is sufficient for determining genera? Probably not always, since studies of Andrews and Pannell (1942) and Felix (1954) have shown that the microspores of *Lepidocarpon* are most nearly assignable to *Lycospora* and spores with and without flanges are present in the cone genus. Thus we may feel justified in the assignment of one group of small spores, possessing a varied ray and flange development, to *Lycospora* and others to *Cirratriradites* because of the morphological nature of the parent fructification. Yet we are forced by necessity to assign the small spore of a third morphological parent entity (*Lepidocarpon*) to *Lycospora* due to an inability to differentiate between the microspores of *Lepidostrobus* and *Lepidocarpon*. That all are from different plants is evident when morphological features of the parent cones are compared, and the megaspores of each is known and differ decidedly from one another.

Chaloner (1958b) has recently added to the uncertainty of lycopodiaceous cone genera identifications by describing *Densosporites* as the microspore of *Selaginellites canonbiensis*. Since *Cirratriradites* appeared to be the only microspore attributable to *Selaginellites*, it is apparent that a broad interpretation of the cone genus has been made. Future investigations of the arborescent and herbaceous lycopods will undoubtedly result in new interpretations. Of primary importance however, is that this represents the first definite correlation of *Densosporites* with a parent cone. These spores have long been one of the most common Paleozoic small spores, and evidence of their relationship is a welcome contribution to paleobotany.

These examples do raise the question as to the reliability of the small spores as indicators of fossil species. A further suggestion of their lack of reliability is illustrated in *Lepidostrobus pulvinatus* (Felix, 1954) where a considerable variation was noted in spores from individual sporangia. The size range and features of the rays and equatorial development differed to the extent that the spores would certainly have been included in more than one species had they been recovered from sediments. Must one assume then that the microspores are of limited use, and

that the megaspores and other plant organs are most reliable in defining species and of more correlative value? In all probability such an assumption is unwarranted since so many of the small spores have already proven of value in both local and regional correlations, but it is evident that much is still unknown about the smaller spores. Further research may well demonstrate the poor characters of some spores, but study could equally well bring clarification and greater value for them to the paleobotanist.

Another interesting case is *Calamospora*, one of the most numerous of the Paleozoic spores, yet one of the least utilized. On the basis of morphological variations several species have been described, but little use has been made of these stratigraphically. The fact that the spores are not easily segregated into restricted generic groupings has impeded their utilization, yet much is known about them, enough that is as to suggest significant developments from a determined effort to study their affinities to parent plants. It is certainly one of the most broadly related genera on the basis of evidence of natural relationships, and it includes both megaspores and microspores. However, present division of the genus renders it quite likely that this inclusion in one morphologic niche has resulted in some heterosporous Calamarian species being recorded under two specific names.

Paleozoic literature abounds with references assigning the spore to a parent plant. Kosanke (1955) has reported *Calamospora* from the homosporous *Mazostachys pendulata*. From the heterosporous *Palaeostachya multifolia*, Anderson (1954) has described megaspores and microspores identified as *Calamospora*. Hoskins and Cross (1943) figured *Calamospora* as the spore of the homosporous *Bowmanites trisporangiatum*, and in their monographic treatment they assembled most of the published data on the spores of other *Bowmanites*. There are numerous publications dealing with the genus *Bowmanites*, a cone which Hoskins and Cross considered to be the fructification of Sphenophyllalean plants and with *Calamospora* as the spore. The question to be asked is whether these spores are sufficiently different morphologically to be distinguished when recovered from sediments? If so, they promise a valuable working tool in view of the known geological occurrence of many of the fructifications.

However, to add further to the uncertainties attending the identification of Calamarian forms is the problem of the proper relationships of these various cone genera containing similar spores. In addition to the previously noted cones, Arnold (1949) has described the cone *Discinites delectus* with megaspores and microspores of the *Calamospora* type. But doubt is cast on the dependability of the spores as generic indicators by *Bowmanites bifurcatus* of Andrews and Mamay (1951). In this *Bowmanites* the spores are reniform, monolete and assignable to *Laevigatosporites* rather than to *Calamospora*. A problem also exists as to the true nature of *Palaeostachya*. Anderson (1954) described *P. multifolia* as heterosporous, but Baxter (1955) has reported *P. andresii* with spores ranging from 270 to 320 microns in diameter and his description indicates that they are *Calamospora*. Delevoryas (1955) has reported *P. decacnema* with spores averaging 45 to 50 microns in diameter and referable to *Calamospora*. Thus the possibility exists that some species possess microspores only and others megaspores. Until further research establishes heterospory, homospory, or both in the genus, the spores can be considered of limited specific importance. Thus we have the spore *Calamospora*, often of considerable quantitative significance and of much morphologic variability, yet tantalizingly of questionable value until we have more knowledge of the true relationship of spores to parent fructifications.

That all problems relating to Sphenophyllalean taxonomy have not been conclusively resolved is further suggested by the association of the spore *Reliculisporites* with apparent sphenopsid cones. Levittan and Barghoorn (1948) have

reported it as the spore of *Sphenostrobus Thompsonii*. Mamay (1954) has figured reticulate spores from *Lithostrobus iowensis*, a cone of Sphenophyllalean affinity.

These examples constitute only a small portion of the issues to be dealt with in plant microfossil classification. They are questions which appear to have solutions if properly studied from the standpoint of megafossils as well as microfossils and with the botanical aspect receiving consideration. Most importantly they reveal to the young researcher the immediate and plentiful problems available for investigation. The opportunities for research in plant microfossil work as related to megafossils is virtually unlimited. Our ignorance of the proper relationships between spores and fructifications for instance is not due to a scarcity of material. The fine coal ball horizons of the mid-continent have revealed many links in the paleobotanical picture, and their resources have scarcely been tapped. The equally promising coal ball localities of the Appalachian region still remain to yield their first publication. The splendid reservoir of research in Paleozoic compressions and impressions has received only the barest attention, and the publications of Chaloner (1952, 1953a, b, c, 1954, 1956, 1958a, b) serve to illustrate the vast untouched potential of museum and academic collections.

There is a readily discernible antipathy towards botanical methods in current plant microfossil studies. Such is frequently the case when a specific field of study becomes popularized and attains a "bandwagonlike" stature, for it is often easier for the non-botanist to ignore the fundamentals upon which paleobotany is based and turn the proven substantiations into usable tools. Admittedly this use of affirmed knowledge is one aim in spore-pollen investigations but not the sole goal. Such an attitude is not progress; it is stagnation, and it bids well to create only capable mechanics and not scientists. Such interpretive discrimination will turn taxonomy into a mere cataloging process if investigators persist in ignoring the significance of the many biocharacters afforded by study of megafossils and their associated microfossils.

There is a real need to remain cognizant of the fact that spore-pollen investigations are basically botanical. Especially is there a need for investigators to collaborate more in sharing results, for it seems that as a rule those who persist in operating amid an atmosphere of secrecy set poor examples and seldom contribute to paleobotanical progress. Cooperation among paleobotanists is essential in order that we may also obtain a general stratigraphic correlation of the megafossils to supplement our spore studies in the solution of stratigraphic and floristic problems of paleobotany.

Much of the responsibility for bringing order from the abundance of information we have on plant microfossils must be directed towards the establishments utilizing the fundamental data. The academic researchers have laid an admirable groundwork, often under difficult circumstances, but they did it slowly and intelligently, not in the pellmell probing for short cuts. Taxonomy studies progress slowly at best and are likely to be treated impatiently by those prone to speedy decisions or the "talent" for resolving every problem even if by a superficial evaluation of data. But thorough taxonomic treatment of fossil plant entities is necessary if real progress is to be realized. This writer does not assume the gross conceit that we can define ancient plants so perfectly as to designate them as "natural" genera or families. There will probably always be certain members of any taxonomic division whose affiliations will be less well understood, or whose definitive characters will be indistinct enough, so that the marginal outlines of the alliance will be established with some degree of unnatural arbitrariness. It is also noted that the author has made free use of the distinguishing of *natural* and *form* genera largely because of time honored precedent, not because he considers them to be good taxonomy.

SUMMARY

There is a need in plant microfossil research to give more attention to nomenclatural problems. Present classification systems often persist in ignoring phyletic relationships even when natural affinities of dispersed spores are evident. Many current taxonomic problems may have solutions if studied from the standpoint of megafossils as well as microfossils and with the botanical aspect considered.

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